



## **MATERIAL SPECIFICATION FOR AGGREGATES - HOT MIX ASPHALT**

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### **1003.01 SCOPE**

This specification covers material requirements for aggregates for use in hot mix asphalt. Quality control and quality assurance procedures and referee testing protocol are incorporated.

#### **1003.01.01 Significance and Use of Appendices**

Appendices are not a mandatory part of this specification unless invoked by the Owner.

**Appendix 1003-A** is a commentary appendix to provide designers with information on the use of this specification in a Contract.

**Appendix 1003-B** is an additional information option that is invoked only when referenced in the Contract Documents by the Owner. This appendix contains a form for reporting HMA fine aggregate test data.

**Appendix 1003-C** is an additional information option that is invoked only when referenced in the Contract Documents by the Owner. This appendix contains a form for reporting HMA coarse aggregate test data.

**Appendix 1003-D** is an additional information option that is invoked only when referenced in the Contract Documents by the Owner. This appendix contains gradation requirements for coarse and fine aggregates.

**Appendix 1003-E** is an additional information option that is invoked only when referenced in the Contract Documents by the Owner. This appendix contains a form for reporting Superpave consensus property requirement test data

## **1003.02 REFERENCES**

This specification refers to the following standards, specifications, or publications:

### **Ontario Provincial Standard Specifications, Material**

OPSS 1001 Aggregates - General  
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

### **Ministry of Transportation, Ontario, Publications**

MTO Laboratory Testing Manual:

LS-601 Materials Finer than 75  $\mu\text{m}$  Sieve in Mineral Aggregates by Washing  
LS-602 Sieve Analysis of Aggregates  
LS-604 Relative Density and Absorption of Coarse Aggregate  
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LS-702 Determination of Particle Size Analysis of Soils  
LS-703/704 Liquid Limit, Plastic Limit and Plasticity Index of Soils

### **American Association of State Highway and Transportation Officials (AASHTO)**

T 176-02 Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test  
T 304-00 Uncompacted Void Content of Fine Aggregate

### **ASTM International**

C 1252-03 Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)  
D 2419-02 Sand Equivalent Value of Soils and Fine Aggregate  
D 4791-99 Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate  
D 5821-01 Determining the Percentage of Fractured Particles in Coarse Aggregate

For the purpose of this specification, the following definitions apply:

**Air-Cooled Blast Furnace Slag** means the material resulting from solidification of molten blast-furnace slag under atmospheric conditions. Subsequent cooling may be accelerated by application of water to the solidified surface.

**Bench** means a ledge parallel to stratigraphic bedding that in quarries forms a single level of operation above which rock is excavated from a contiguous face.

**Business Day** means any Day except Saturdays, Sundays, or statutory holidays.

**CCIL** means the Canadian Council of Independent Laboratories.

**Coarse Aggregate** means that portion of an aggregate material retained on the 4.75 mm sieve when tested according to LS-602.

**Consensus Aggregate Property** means an aggregate characteristic required to satisfy the Superpave method of mix design.

**Control Chart** means a graphical method used to monitor the central tendency and the variability of a material characteristic in order to control production.

**Copper Slag** means the non-metallic co-product resulting from the production of copper.

**Duplicate Samples** means two samples taken at the same time and location.

**Equivalent Single Axle Load (ESAL)** means equating the damage to a pavement structure caused by the passage of a non-standard load to a standard 80 kN axle load.

**Fine Aggregate** means that portion of aggregate material passing the 4.75 mm sieve when tested according to LS-602.

**Hot Mix Asphalt (HMA)** means hot mixed, hot laid asphaltic concrete. The terms are used interchangeably. HMA may include recycled or specialty mixes.

**Mean** means the arithmetic average of a set of data.

**Nickel Slag** means the non-metallic co-product resulting from the production of nickel.

**Physical Property** means an inherent attribute or feature of an aggregate material to determine a material's resistance to weathering or degradation.

**Quality Assurance (QA)** means a system or series of activities carried out by the Owner to ensure that materials received from the Contractor meet the specified requirements.

**Quality Control (QC)** means a system or series of activities carried out by the Contractor to ensure that materials supplied to the Owner meet the specified requirements.

**Reclaimed Asphalt Pavement (RAP)** means the processed HMA material that is recovered by partial or full depth removal.

**Referee Testing** means testing by an independent laboratory selected by the Owner and acceptable to the Contractor, the results of which are used for resolving differences between QC and QA testing.

**Statistical Control** means when all sources of assignable variation have been removed, the variability of the process is confined to probability variation alone.

**Steel Slag** means the non-metallic co-product resulting from the production of steel in a basic oxygen furnace or an electric arc furnace.

**Stone Mastic Asphalt or Stone Matrix Asphalt (SMA)** means HMA consisting of two parts of a coarse aggregate skeleton and an asphalt binder rich mortar. The mix has a gap graded aggregate skeleton with coarse aggregate stone-on-stone contact.

**Superpave** means an acronym for Superior Performing Asphalt Pavements. It is an alternative system to the Marshall method for specifying material components and asphalt mix design using the Superpave gyratory compactor.

## **1003.04 SUBMISSION AND DESIGN REQUIREMENTS**

### **1003.04.01 Submission of Test Data**

The Contractor shall have available test results of the aggregates and filler to be used in the work. At the request of the Contract Administrator, the Contractor shall make available or submit QC test results prior to the delivery of the material. Test results shall be submitted by either the stockpile or control chart method.

Individual test results may be submitted using forms provided by the Owner.

#### **1003.04.01.01 Stockpile Method**

Test data shall be obtained from samples taken from aggregate stockpiles to be used in the work, except when the quantity of HMA is less than 5,000 tonnes. In this case, the test data obtained within the past 12 months from the same location within the source that is to be used in the work may be provided.

#### **1003.04.01.02 Control Chart Method**

Type 1 control charts shall be prepared according to LS-624 or similar method. Each control chart shall contain the results of testing and information regarding control limits, specification limits, target values, testing frequency, sampling location, and time period over which the testing has taken place.

## **1003.05 MATERIALS**

### **1003.05.01 General**

The requirements of OPSS 1001 shall apply to this specification. Material shall be according to this specification when tested according to the MTO Laboratory Testing Manual. Aggregates and filler material shall be according to this specification, when tested according to the methods given in this specification.

Aggregates may be sands, gravels, quarried rock, or RAP, provided the source is of such a nature and extent as to ensure acceptable processed aggregates of a consistent gradation and quality.

Coarse and fine aggregates for SMA, DFC, OFC, and Superpave 12.5 FC2 shall be produced by crushing bedrock material. Coarse aggregate for HL 1 and Superpave 12.5 FC1 shall be produced by crushing bedrock or gravel.

In locations shown in Note 3 of Table 6, there are restrictions on the maximum amount of limestone or dolostone in Superpave 12.5 coarse aggregate. Material passing the 4.75 mm sieve, and retained on the 2.36 mm sieve shall meet the same requirements detailed in Note 3 for the coarse aggregate.

For Superpave 12.5 FC1 mixes, 90% of the total aggregate in the mix retained on the 2.36 mm sieve shall come from a source specified in the Contract Documents.

Coarse aggregates for HDHC shall be produced by crushing either bedrock material, gravel, cobble, or boulder material retained on the 50.0 mm sieve. Fine aggregates for HDHC shall be produced by crushing either bedrock material, gravel, cobble, or boulder material retained on the 9.5 mm sieve.

If necessary, coarse and fine aggregates for HDHC shall be processed to meet the HMA requirements specified in the Contract Documents, including washing and classification.

Coarse aggregate for HL 1 and Superpave 12.5 FC1 and coarse and fine aggregates for SMA, DFC, and Superpave 12.5 FC2 shall be supplied only from sources specified in the Contract Documents. Both the coarse and fine aggregates for SMA, DFC, and Superpave 12.5 FC2 shall be obtained from the same source. Blending of aggregates for SMA, DFC, and Superpave 12.5 FC2 from different sources is not permitted.

Steel slag, nickel slag, and copper slag are not acceptable for use in HMA. RAP containing steel slag is not permitted.

Irrespective of compliance or non-compliance with the physical requirements, aggregates may be accepted or rejected on the basis of field performance. The pavement with which satisfactory field performance is demonstrated shall have been in a similar environment and application to that in which the aggregate is proposed for use and shall be at least 10 years old. A petrographic study shall be conducted to demonstrate that the aggregate in the original pavement is the same as that under consideration. Field performance shall be determined by the Owner.

Blending of aggregates shall be permitted at the hot mix plant.

The Contractor shall elect to either:

- a) Have QA sampling and testing done on a stockpile basis, when each aggregate stockpile shall meet the physical requirements; or
- b) Have QA sampling and testing of the material after the cold feed bins, but before the material is mixed with liquid asphalt cement, when the combined fine aggregates and the combined coarse aggregates shall meet the physical requirements.

If the Contractor elects to use process b) above, and one or more components do not by themselves meet this specification, the Contractor shall notify the Contract Administrator and provide a QC process satisfactory to the Contract Administrator.

## **1003.05.02            Fine Aggregate**

### **1003.05.02.01            Gradation Requirements**

Fine aggregates shall be graded so that when combined with other aggregates, they consistently meet the overall gradation of the HMA specified in the Contract Documents.

### **1003.05.02.02            Physical Property Requirements**

Fine aggregates shall be composed of clean, hard, durable particles meeting the requirements of Table 1. When the Contractor has elected to have QA sampling of blended aggregates from the cold feed, the Micro-Deval Abrasion loss of each individual fine aggregate shall not exceed 35%, and the overall blend shall meet the requirements shown in Table 1.

For Superpave HMA, the fine aggregate blend, including blended RAP materials, as identified in the submitted mix design, shall also meet the consensus aggregate property requirements for uncompacted voids shown in Table 2 for the traffic category specified in the Contract Documents.

**1003.05.03 Coarse Aggregate**

**1003.05.03.01 Gradation Requirements**

Coarse aggregates shall be graded so that when combined with other aggregates, they consistently meet the overall gradation of the HMA specified in the Contract Documents.

**1003.05.03.02 Physical Property Requirements**

Coarse aggregates for use in HL 1, SMA, and DFC shall be according to the physical requirements of Table 4. Coarse Aggregates for use in HL 3, HL 3HS, HL 3F, HL 4, HL 4F, HL 8, HDBC, and MDBC shall be according to the physical requirements of Table 5.

Coarse aggregates for Superpave HMA surface course mixes 4.75, 9.5, 12.5, 12.5 FC1, and 12.5 FC2 shall be according to the requirements of Tables 2 and 6. Coarse aggregates for Superpave HMA binder or leveling course mixes 4.75, 9.5, 19.0, 25.0, and 37.5 shall be according to the requirements of Tables 2 and 7.

When the Contractor elects to sample blended coarse aggregates from the cold feed to show conformance with this specification, the blended coarse aggregate shall also meet the above requirements. Blending of aggregates for SMA, DFC, and Superpave 12.5 FC2 from different sources is not permitted.

**1003.05.04 Reclaimed Asphalt Pavement**

When RAP is used in HMA, it shall be processed for such use.

The coarse aggregate portion of RAP shall meet the applicable physical requirements for Marshall mixes shown in Tables 4 and 5, and for Superpave mixes shown in Tables 6 and 7, for percent crushed particles according to LS-607 and flat and elongated particles according to LS-608.

The combined coarse aggregate for use in Superpave HMA containing blended RAP material shall meet the consensus aggregate property requirements according to Table 2.

The combined fine aggregate for use in Superpave HMA containing blended RAP material shall meet the consensus aggregate property requirements for the uncompacted void content according to Table 2. When the combined fine aggregate contains RAP materials, the requirement for sand equivalent according to AASHTO T 176 or ASTM D 2419 is waived.

**1003.05.05 Filler**

Filler shall consist of mineral filler, hydrated lime, Portland cement, or other material as designated and currently approved by the Owner for use in HMA. For SMA, the filler shall be mineral filler. Mineral filler shall be produced from rock sources acceptable for coarse aggregates meeting the physical requirements shown in Tables 6 and 7 for Superpave mixes. Mineral filler shall be sufficiently dry so as to flow freely, free from agglomerations, non-plastic according to LS-703/704, and meet the following gradation requirements according to LS-702:

- a) 100% passing 600  $\mu\text{m}$  sieve.
- b) 95 to 100% passing 300  $\mu\text{m}$  sieve.
- c) 70 to 100% passing 75  $\mu\text{m}$  sieve.
- d) Not more than 20% passing 20  $\mu\text{m}$  sieve, SMA only.

**1003.07                      PRODUCTION**

**1003.07.01                      Aggregate Processing, Handling, and Stockpiling**

Processed aggregates shall be separated into fine and coarse aggregates and stockpiled separately.

Aggregates separated during processing, aggregate secured from different sources, and aggregates from the same source but of different gradations shall be placed in individual stockpiles.

When screenings from primary and secondary crushers are produced separately, they shall be stockpiled separately.

Aggregates that have become mixed with foreign matter of any description or aggregates that have become mixed with each other shall not be used and shall be immediately removed from the stockpile. When a change in the character of the materials occurs or when the performance of materials that meet the requirements of this specification is found to be unsatisfactory, use of the materials shall be discontinued until a reappraisal by the Contractor, with the approval of the Contract Administrator, proves the source to be satisfactory.

Once a stockpile has been produced, sampled, and tested for QC under the procedure for stockpile method, no further materials may be added to the stockpile. Stockpiles tested under the procedure for control chart method may continue to have materials added, provided that sampling and testing show that materials in the stockpile are according to this specification and that the process remains in statistical control.

Material shall be retained in stockpiles until QC testing has been completed. Suitable stockpile locations are the site of mixing of the HMA, the aggregate source, or any other location acceptable to the Contract Administrator.

**1003.07.02                      Quality Control**

**1003.07.02.01                      General**

The Contractor shall be responsible for all QC sampling and testing required to show conformance of the aggregates with this specification. QC testing for gradation according to LS-602, percent crushed particles according to LS-607, and materials finer than 75 µm by washing according to LS-601, shall be conducted at regular intervals and at a frequency chosen by the Contractor. These records shall be made available upon request by the Contract Administrator. Test results shall be for either the stockpile or control method.

**1003.07.02.02                      Laboratory Requirements**

The Contractor shall select all QC laboratories and shall be responsible for all costs associated with the testing for QC requirements.

An acceptable laboratory to conduct tests for physical and consensus properties shall be one that holds a current Type D certificate from CCIL for the applicable test methods and also participates in the Annual MTO Proficiency Sample Testing Program for the specific tests.

An acceptable laboratory to conduct tests for gradation according to LS-602 and materials finer than 75 µm by washing of the aggregates according to LS-601 shall be one that holds a current Type C certificate from CCIL. Such testing shall be conducted by qualified laboratory staff that hold a valid certificate from CCIL in aggregate testing.

Equal alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements, provided they are acceptable to the Contract Administrator.

### **1003.07.02.03            Stockpile Method**

Testing demonstrating conformance of the aggregates to the physical requirements of this specification shall be completed for each quantity of material produced according to the following schedule:

- a) For the first 20,000 tonnes of HMA produced.
- b) For the next 20,000 tonnes of HMA produced.
- c) For each 40,000 tonnes of HMA produced thereafter.

Further testing is required whenever material is produced from a new source or a new bench in a quarry or whenever a significant change in aggregate production or material occurs that may affect the quality of the material.

### **1003.07.02.04            Control Chart Method**

The Contractor shall use a Type 1 control chart as defined in LS-624 for each physical requirement. When the control chart has been established, the minimum frequency of sampling and further testing shall be one of the following:

- a) Annually, i.e., obtained within the past 12 months, when the mean value of the physical property is less than or equal to the values given in Table 8 and when the Type 1 control chart demonstrates the process to be in statistical control.
- b) Three times a year, spaced evenly throughout the aggregate production schedule, when the mean value of the physical property is greater than the values given in Table 8 or when the Type 1 control chart demonstrates the process to be out of statistical control.

## **1003.08                    QUALITY ASSURANCE**

### **1003.08.01            General**

The Contract Administrator shall be allowed access to all sampling locations and reserves the right to request a QA sample at any time. The Contract Administrator may elect to carry out testing at a QA laboratory to ensure that the materials are according to the requirements of this specification.

### **1003.08.02            Sampling**

Sampling shall be conducted by the Contractor according to LS-625.

QA samples shall be taken from stockpiles at the hot mix plant or from after the cold feed at the plant, but before the addition of liquid asphalt cement. The place of sampling shall be determined by the Contractor.

QA samples taken from stockpiles at the hot mix plant shall be from stockpiles that contain a minimum quantity of 500 tonnes of each aggregate for each HMA.

QA samples taken from after the cold feed during production of the HMA shall be taken at a time determined by the Contract Administrator.

Duplicate samples shall be obtained and sealed by the Contractor in the presence of the Contract Administrator. In the event that the Contractor is unavailable to take the sample, no further materials shall be placed in the work until the QA sample has been taken. Samples shall meet the requirements of Table 9. Samples shall be of sufficient mass of the material to conduct the necessary gradation and physical property tests.

All samples for the Owner shall be delivered within 24 hours of sampling to a location designated in the Contract Documents.



### **1003.08.03                      Laboratory Requirements**

The Contract Administrator shall designate the QA laboratories and will be responsible for all costs associated with QA testing.

An acceptable laboratory conducting tests for physical and consensus properties shall be one that holds a current Type D certificate from CCIL for the applicable test methods and also participates in the Annual MTO Proficiency Sample Testing Program for the specific tests.

An acceptable laboratory for testing gradation according to LS-602, percent crushed particles according to LS-607, and materials finer than 75  $\mu\text{m}$  by washing of the aggregates according to LS-601 shall be one that holds a current Type C certificate from CCIL. Such testing shall be conducted by qualified laboratory staff that hold a valid certificate from CCIL in aggregate testing.

Equal alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements, provided they are acceptable to the Contract Administrator.

### **1003.08.04                      Testing and Retention of Samples**

When the Contract Administrator elects to carry out QA testing, one of the duplicate samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing. Samples taken from the stockpiles shall be treated as individual samples. Samples taken from after the cold feed shall be separated on the 4.75 mm sieve and the fine aggregate portion and the coarse aggregate portion tested as the fine or the coarse aggregate of the mix, even though a combination of aggregates may have been used in forming the fine or coarse aggregate.

### **1003.08.05                      Acceptance**

When the Contract Administrator elects not to carry out QA sampling and testing, the material shall be accepted as provided. When QA testing is carried out, the results shall be used for acceptance purposes, except when referee testing has been carried out.

When QA test results show that the material meets the physical requirements of this specification, the material shall be accepted.

When QA test results show that the material does not meet the physical requirements, the Contract Administrator shall notify the Contractor that tested materials from a particular source, including materials in existing stockpiles or in the work, shall not be accepted. The Contractor shall be notified without delay and in writing within 3 Business Days of receipt of the non-conforming data. The Contractor has the option of either removing the material from the work or invoking referee testing.

### **1003.08.06                      Referee Testing**

When QA test results do not meet the requirements of this specification, the Contractor has the option of invoking referee testing of the test result that fails to meet the requirements. The Contractor shall inform the Contract Administrator of the selected option within 2 Business Days following written notification.

The Contract Administrator shall select a referee laboratory acceptable to the Contractor, within 3 Business Days following the Contractor's notification to invoke referee testing. Referee samples shall be delivered to the referee laboratory from the QA laboratory by the Contract Administrator. The sealed sample shall be opened in the presence of the Contractor and the Contract Administrator.

Referee testing shall be carried out in the presence of the Contract Administrator. When applicable, the referee laboratory shall also test a control aggregate sample for each test method required. The Contractor may observe the testing at no cost to the Owner. Comments on the nonconformity of the test methods must be made and corrected at the time of testing. Referee test results shall be binding on both the Owner and the Contractor.

When a referee test result shows that the aggregates do not meet the requirements of this specification, the material represented by the test result, including materials in existing stockpiles or in the work, shall not be accepted. The Contractor shall remove the material from the work at no cost to the Owner.

When a referee test result shows that the aggregates are in complete conformance with the requirements of this specification, the material represented by the sample, including materials in existing stockpiles or in the work, shall be accepted.

The Owner will be responsible for the cost of referee testing, provided that the referee test results show that the aggregates meet the applicable specifications, otherwise, the Contractor shall be responsible for the costs.

**Table 1**  
**Physical Requirements for Fine Aggregates**

Laboratory Test	MTO Test Number	Surface Course			Binder Course
		SMA 9.5 and 12.5, DFC, and Superpave 12.5 FC2	HL 1, HL 3, HL 3HS, HL 3F, and Superpave 4.75, 9.5, and 12.5 FC1	HL 2, HL 4, and Superpave 12.5	HL 2, HL 4, HL 4F, HL 8, HDBC, MDBC, SMA 19.0, and Superpave 4.75, 9.5, 19.0, 25.0, and 37.5
Micro-Deval Abrasion loss, % maximum	LS-619	15	20	25	25
Plasticity Index, maximum	LS-703/704	0	0	0	0

**Table 2**  
**Consensus Property Requirements for Superpave Aggregates Only**

Ontario Traffic Category (Note 1)	Sand Equivalent, % minimum AASHTO T 176 or ASTM D 2419 Method 1 (Note 2)	Uncompacted Void Content, % minimum AASHTO T 304 or ASTM C 1252 Method A		Flat and Elongated Particles, % maximum at 5:1 ASTM D 4791 (Note 4)	Fractured Particles in Coarse Aggregate, % minimum ASTM D 5821	
		≤100 mm (Note 3)	>100 mm		≤100 mm (Note 3)	>100 mm
A	40	-	-	-	60/-	60/-
B	40	40	40	10	75/-	60/-
C	45	45 (Note 5)	40		85/80 (Note 6)	60/-
D	45	45 (Note 5)	40		95/90	80/75
E	50	45 (Note 5)	45 (Note 5)		100/100	100/100

Notes:

- The traffic categories are according to Table 3.
- This requirement is waived for total fine aggregate containing RAP.
- Denotes the depth of the top of lift below final pavement surface. If less than 25% of a layer is within 100 mm of the surface, the layer may be considered to be below 100 mm.
- Measured according to ASTM D 4791, with the exception that the material passing the 9.5 mm sieve and retained on the 4.75 mm sieve shall be included. The aggregate shall be measured using the ratio 5:1, comparing the length (longest dimension) to the thickness (smallest dimension) of the aggregate particles. If the ratio 4:1 meets specification, the ratio 5:1 is waived.
- A minimum uncompacted void content of 43% is acceptable provided that the selected mix satisfies the mix volumetrics specified in OPSS 1151.
- 85/80 denotes that 85% of the coarse aggregate has one fractured face and 80% has two or more fractured faces.

**Table 3**  
**Superpave and SMA Design Traffic Categories by ESALs**

<b>Ontario Traffic Category</b>	<b>20-Year Design ESALs (Note 1)</b>	<b>Typical Applications</b>
A	Less than 0.3 million	Low volume roads, parking lots, driveways, and residential roads.
B	0.3 to 3 million	Minor collector roads.
C	3 to 10 million	Major collector and minor arterial roads.
D	10 to 30 million	Major arterial roads and transit routes.
E	Greater than 30 million	Freeways, major arterial roads with heavy truck traffic, and special applications such as truck and bus climbing lanes or stopping areas.

Note:

1. Equivalent Single Axle Load (ESAL) for the projected traffic level expected in the design lane over a 20-year period, regardless of the actual design life of the pavement.

**Table 4**  
**Physical Requirements for Coarse Aggregate for HL 1, SMA 9.5 and 12.5, and DFC**

<b>Laboratory Test</b>	<b>MTO Test Number</b>	<b>Material Type</b>			
		<b>Gravel HL 1 Only</b>	<b>Quarry Rock</b>		
			<b>Dolomitic Sandstone</b>	<b>Traprock, Diabase, and Andesite</b>	<b>Meta-Arkose, Meta-Gabbro, and Gneiss</b>
Loss by Washing, Pass 75 µm Sieve, % maximum (Note 1)	LS-601	1.0	1.0	1.0	1.0
Absorption by Mass, % maximum	LS-604	1.0	1.0	1.0	1.0
Flat and Elongated Particles, % maximum	LS-608	15	15	15	15
Petrographic Number, maximum	LS-609	120	145	120	145
Insoluble Residue, retained 75 µm, % minimum	LS-613	-	45	-	-
Freezing and Thawing, % loss maximum	LS-614	6	7	6	6
Particles with 2 Faces Crushed, % minimum	LS-617	80	-	-	-
Micro-Deval Abrasion loss, % maximum	LS-618	5	15	10	15

Note:

1. When control charts for n>20 are used for LS-601, the average value shall not exceed the specification maximum of 1.0%, with no single value greater than 1.4%.

**Table 5**  
**Physical Requirements for Coarse Aggregate for HL 3, HL 4, HL 8, HDBC, MDBC, and SMA 19.0**

<b>Laboratory Test</b>	<b>MTO Test Number</b>	<b>HL 3, HL 3F, and HL 3HS</b>	<b>HL 4 Surface and HL 4F (Note 1)</b>	<b>HL 4 Binder and HL 8</b>	<b>HDBC and SMA 19.0</b>	<b>MDBC</b>
Loss by washing, Pass 75 µm Sieve, % maximum	LS-601	1.3 (Note 2)	1.3 (Note 2)	1.3 (Note 2)	1.3 (Note 2)	1.3 (Note 2)
Absorption, % maximum	LS-604	1.75	2.0	2.0	2.0	2.0
Unconfined Freeze-Thaw Loss, % maximum (Note 3)	LS-614	6	6	15	15	15
Percent Crushed Particles, % minimum	LS-607	60	60	60	-	95
Particles with 2 Faces Crushed, % minimum (Note 4)	LS-617	-	-	-	95	80
Flat and Elongated Particles, % maximum	LS-608	20	20	20	15	15
Petrographic Examination non-carbonate of retained 4.75 mm, % minimum	LS-609	60 (Note 5)	60 (Note 5)	-	-	-
Micro-Deval Abrasion, % maximum loss	LS-618	17	17	21	21	21

**Alternative Requirement for Unconfined Freeze-Thaw Loss, LS-614**

Magnesium Sulphate Soundness, % maximum loss	LS-606	12	12	15	15	15
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Notes:

1. These physical requirements for HL 4 shall apply when the HMA forms the surface upon which vehicular traffic will directly travel, otherwise, the physical requirements for HL 4 binder shall apply.
2. When control charts for n>20 are used for LS-601, the average value shall not exceed the specification maximum of 1.3%, with no single value greater than 1.7%. When quarried rock is used as a source of coarse aggregate, a maximum of 2.0% passing the 75 µm sieve shall be permitted. When control charts for n>20 are used for LS-601 for quarried rock, the average value shall not exceed the specification maximum of 2.0%, with no single value greater than 2.4%.
3. The requirements shall be waived by the Owner when the aggregate meets the alternative magnesium sulphate soundness requirements, LS-606, as detailed in Table 8.
4. This only applies to HDBC and MDBC coarse aggregate crushed from gravel sources. The maximum allowable amount of uncrushed particles is 5%, MDBC only.
5. For the locations listed below, when the coarse aggregate for surface course mix is obtained from a gravel pit or quarry containing more than 40% limestone and dolostone in the retained 4.75 mm portion of the coarse aggregate, then blending with aggregate of non-carbonate rock type shall be required. The blend shall be such as to increase the non-carbonate rock type content of the coarse aggregate to 60% minimum of the retained 4.75 mm portion, as determined by petrographic examination LS-609. When the coarse aggregate for surface course mix is obtained from a non-carbonate source, blending with carbonate rocks, limestone and dolostone, shall not be permitted. The method of blending shall be such as to produce uniform blending and shall be subject to approval by the Owner. In cases of dispute, the acid insoluble residue test LS-613 shall be used with a minimum acid insoluble residue of 60%. When the aggregate for surface course mix is obtained from a non-carbonate gravel or quarry source, blending with carbonate rock types shall not be permitted.

This requirement is applicable to surface course aggregates in the area to the north and west of a boundary defined as follows: the north shore of Lake Superior, the north shore of the St. Mary's River, the south shore of St. Joseph Island, the north shore of Lake Huron easterly to the north and east shore of Georgian Bay, excluding Manitoulin Island, along the Severn River to Washago and a line easterly passing through Norland, Burnt River, Burleigh Falls, Madoc, and hence easterly along Highway 7 to Perth and northerly to Calabogie and easterly to Amprior and the Ottawa River.

**Table 6  
Physical Requirements for Coarse Aggregate, Superpave Surface Course**

Laboratory Test	MTO Test Number	Superpave 4.75, 9.5, and 12.5	Material Type			
			Gravel (Superpave 12.5 FC1 only)	Quarry Rock		
				Superpave 12.5 FC1 and Superpave 12.5 FC2		
				Dolomitic Sandstone	Traprock, Diabase, and Andesite	Meta-Arkose, Meta-Gabbro, and Gneiss
Loss by Washing, Pass 75 µm Sieve, % maximum	LS-601	1.3 (Note 1)	1.0 (Note 2)	1.0 (Note 2)	1.0 (Note 2)	1.0 (Note 2)
Absorption by Mass, % maximum	LS-604	2.0	1.0	1.0	1.0	1.0
Flat and Elongated Particles, % maximum (4:1)	LS-608	20	15	15	15	15
Petrographic Number, HL, maximum	LS-609	(Note 3)	120	145	120	145
Insoluble Residue, retained 75 µm, % minimum	LS-613	-	-	45	-	-
Freezing and Thawing, % loss maximum (Note 4)	LS-614	6	6	7	6	6
Micro-Deval Abrasion loss, % maximum	LS-618	17	5	15	10	15
<b>Alternative Requirement for Unconfined Freeze-Thaw Loss (LS-614)</b>						
Magnesium Sulphate Soundness, % maximum loss	LS-606	12	-	-	-	-
Notes:						
<p>1. When control charts for n&gt;20 are used for LS-601, the average value shall not exceed the specification maximum of 1.3%, with no single value greater than 1.7%. When quarried rock is used as a source of coarse aggregate, a maximum of 2.0% passing the 75 µm sieve shall be permitted. When control charts for n&gt;20 are used for LS-601 for quarried rock, the average value shall not exceed the specification maximum of 2.0%, with no single value greater than 2.4%.</p> <p>2. When control charts for n&gt;20 are used for LS-601, the average value shall not exceed the specification maximum of 1.0%, with no single value greater than 1.4%.</p> <p>3. For the locations listed below, Petrographic Number, HL, is replaced by the following requirement: When the coarse aggregate for use in surface course is obtained from a gravel pit or quarry containing more than 40% limestone and dolostone in the retained 4.75 mm portion of the coarse aggregate, then blending with aggregate of non-carbonate rock type shall be required. The blend shall be such as to increase the non-carbonate rock type content of the coarse aggregate to 60% minimum of the retained 4.75 mm portion, as determined by petrographic examination LS-609. The method of blending shall be such as to produce uniform blending and shall be subject to approval by the Owner. In cases of dispute, the acid insoluble residue test LS-613 shall be used with a minimum acid insoluble residue of 60%. When the aggregate for surface course mix is obtained from a non-carbonate gravel or quarry source, blending with carbonate rock types shall not be permitted.</p> <p>This requirement is applicable to surface course aggregates in the area to the north and west of a boundary defined as follows: the north shore of Lake Superior, the north shore of the St. Mary's River, the south shore of St. Joseph Island, the north shore of Lake Huron easterly to the north and east shore of Georgian Bay, excluding Manitoulin Island, along the Severn River to Washago and a line easterly passing through Norland, Burnt River, Burleigh Falls, Madoc, and hence easterly along Highway 7 to Perth and northerly to Calabogie and easterly to Arnprior and the Ottawa River.</p> <p>4. The requirements shall be waived by the Owner when the aggregate meets the alternative magnesium sulphate soundness requirements, LS-606.</p>						

**Table 7  
Physical Requirements for Coarse Aggregates, Superpave Binder Course**

<b>Laboratory Test</b>	<b>MTO Test Number</b>	<b>Superpave 4.75, 9.5, 19.0, 25.0, and 37.5</b>
Loss by Washing, Pass 75 µm Sieve, % maximum	LS-601	1.3 (Note 1)
Absorption, % maximum	LS-604	2.0
Unconfined Freeze-Thaw Loss, % maximum (Note 2)	LS-614	15
Micro-Deval Abrasion, % maximum loss	LS-618	21
Flat and Elongated Particles, % maximum at 4:1	LS-608	20 (Note 3)
<b>Alternative Requirement for Unconfined Freeze-Thaw Loss (LS-614)</b>		
Magnesium Sulphate Soundness, % maximum loss	LS-606	15
Notes:		
<p>1. When control charts for n&gt;20 are used for LS-601, the average value shall not exceed the specification maximum of 1.3%, with no single value greater than 1.7%. When quarried rock is used as a source of coarse aggregate, a maximum of 2.0% passing the 75 µm sieve shall be permitted. When control charts for n&gt;20 are used for LS-601 for quarried rock, the average value shall not exceed the specification maximum of 2.0%, with no single value greater than 2.4%.</p> <p>2. This requirement shall be waived by the Owner when the aggregate meets the alternative magnesium sulphate soundness requirements, LS-606.</p> <p>3. For traffic categories D and E, Superpave 19.0 shall be 15% maximum.</p>		

**Table 8**  
**Values for Determination of Testing Frequency for Control Chart Use**

Test Method	MTO Test Number	Fine Aggregate	HL 1, SMA, DFC, and Superpave 12.5 FC1, and 12.5 FC2	HL 3, HL 3HS, and Superpave Surface Course 4.75, 9.5, and 12.5	HL 4 Surface	HL 4 Binder, HL 8, MDBC, and Superpave Base Course, 19.0, 25.0, and 37.5	HDBC
Loss by Washing, Pass 75 µm Sieve, %	LS-601	-	(Note 1)				
Gradation, % passing	LS-602	-	(Note 1)				
Absorption by Mass, %	LS-604	-	0.75	1.3	1.5	1.5	1.5
Magnesium Sulphate Soundness loss %	LS-606	-	-	9.0	9.0	11.0	11.0
Percent Crushed Particles, %	LS-607	-	(Note 1)				
Particles with 2 Faces Crushed, %	LS-617	-	(Note 1)	-	-	(Note 1)	(Note 2)
Percent Flat and Elongated Particles, %	LS-608	-	11.0	15.0	15.0	15.0	11.0
Petrographic Number, HL	LS-609	-	(Note 3)	-	-	-	-
Petrographic Examination, % non-carbonate of retained 4.75 mm (Note 4)	LS-609	-	-	(Note 5)	(Note 5)	-	-
Insoluble Residue. retained 75 µm, (Note 6)	LS-613	-	(Note 7)	-	-	-	-
Freeze Thaw loss %	LS-614	-	4.0	4.0	4.0	11.0	11.0
Micro-Deval Abrasion loss, Coarse Aggregate, %	LS-618	-	(Note 8)	13.0	13.0	16.0	16.0
Micro-Deval Abrasion loss, Fine Aggregate, %	LS-619	(Note 9)	-	-	-	-	-
Plasticity Index	LS-703/704	(Note 7)	-	-	-	-	-

Notes:

1. Frequency to be chosen by the Contractor.
2. Daily or every 1,000 tonnes.
3. Values are: 115 for gravel in HL 1 and Superpave 12.5 FC1 only, traprock, diabase, and andesite and 135 for dolomitic sandstone, meta-arkose, meta-gabbro, and gneiss.
4. For gravel only.
5. Always do three times per year, except when blending to meet the requirements of Note 6 of Table 5 and Note 4 of Table 6, and then do daily or every 1,000 tonnes.
6. For dolomitic sandstone only.
7. Always do three times per year.
8. Values are: 3.0 for gravel in HL 1 and Superpave 12.5 FC1 only; 10.0 for dolomitic sandstone, meta-arkose, meta-gabbro and gneiss; and 7.0 for traprock, diabase, and andesite.
9. Values are: 11.0 for SMA, DFC, and Superpave 12.5 FC2; 15.0 for HL 1, HL 3, HL 3HS, and Superpave Surface Course 4.75, 9.5, 12.5, and 12.5 FC1; and 19.0 for HL 2, HL 4, HL 8, HDBC, MDBC, and Superpave Base Course 19.0, 25.0, and 37.5.



**Table 9**  
**Sample Size**

<b>Material</b>	<b>Minimum Mass of Field Samples kg</b>
Fine aggregate.	15
Coarse aggregate.	30
Combined coarse and fine aggregate sampled from the cold feed, prior to the addition of asphalt cement.	45
Other Mixes - HL 1, SMA, DFC, and Superpave 12 FC1 and 12 FC2.	50
Note:	
A. Each individual container shall hold no more than 25 kg of aggregate.	

## Appendix 1003-A, Commentary for OPSS 1003, November 2004

**Note:** This appendix does not form part of the standard specification. It is intended to provide information to the designer on the use of this specification in the Contract.

### Designer Action/Considerations

The designer should be aware that OPSS 1003 includes the introduction of Superpave mixes and new physical test methods.

The designer should specify the following in the Contract Documents:

- Aggregate source for Superpave 12.5 FC1 mixes. (1003.05.01)
- Hot mix asphalt (HMA) type requirements. (1003.05.01)
- Traffic category. (1003.05.02.02)
- Storage and delivery requirements for quality assurance (QA) samples. (1003.08.02)

The designer shall determine if the forms in Appendices 1003-B, 1003-C, and 1003-E are to be used for submission purposes. If so, they need to be invoked by reference in the Contract Documents.

The designer should be aware that the use of steel slag is prohibited because of deleterious expansion associated with the hydration of lime (CaO) and periclase (MgO) within the slag. Nickel and copper slags are prohibited because of performance concerns.

The designer should be aware that air-cooled blast furnace slag has been used successfully in HMA. The use of air-cooled blast furnace slag is not prohibited. However, if desired, it is the responsibility of the designer to specify physical requirements of air-cooled blast furnace slags, since they do not normally meet the physical requirements of natural aggregates.

The designer should be aware that fine and coarse aggregate gradations are not given in this specification. For quality control (QC) of any specific operation, the Contractor should develop an average gradation for the particular source and production facilities and control the gradation within reasonable tolerances from this average in such a way as to ensure a suitable HMA meeting the requirements of the Contract Documents. For the information of aggregate suppliers and others, the gradation requirements for fine and coarse aggregate are included in Appendix 1003-D. If the information in Appendix 1003-D is required, the designer should invoke it in the Contract Documents.

The designer should be aware that blending to improve the physical properties of aggregates is not permitted by OPSS 1001, except to increase the percentage of crushed particles or decrease the percentage of flat and elongated particles. In this specification, blending of aggregates shall be permitted at the hot mix plant, provided it takes place at the cold feed and it is possible to take a sample of the blended aggregate. This permits the use of small amounts of material such as coarse crusher screenings that do not normally meet the specification, provided that the overall physical properties of the aggregate mix meet the specification. The Contractor may elect to either have quality assurance (QA) testing done on a stockpile basis, in which case each aggregate stockpile shall meet the physical requirements, or have QA testing done of the material after the cold feed bins, but before the material is mixed with asphalt cement.

The specification requires that coarse and fine aggregates for SMA, DFC, and Superpave 12.5 FC2 to be from the same aggregate source. As experience with Superpave 12.5 FC2 mixes develop, the designer may consider permitting aggregates from other approved aggregate sources of similar rock type.

## **Appendix 1003-A**

The designer should be aware that QA testing may be carried out by the Contract Administrator for purposes of ensuring that the materials used in the work are according to the requirements of OPSS 1003. The decision as to the need to conduct QA testing should be made based on the size, complexity, and desired service life of the work. The designer should specify the frequency of QA testing in the Contract Documents. In the event that the Contract Administrator elects not to carry out QA testing, QC test data may be used for acceptance purposes at the risk of the Owner. In this case the minimum frequency of QC sampling and testing should be specified.

The designer should be aware of any additional referee testing laboratory requirements, including time lines, selection criteria, or roster for referee laboratories and include them in the Contract Documents.

The designer should be aware that the requirement for a minimum of 60% non-carbonate aggregate outlined in Table 6, Note 4, in certain parts of the province is based on the following considerations: Carbonate aggregates due to their low resistance to abrasion polish easily under traffic, and depending on traffic volume may result in pavements with relatively differing frictional properties. In areas of the province with a predominant type of rock, siliceous or carbonate, it has been found that it is best to give consistent frictional properties to pavement surfaces.

The designer should be aware that in cases of high traffic volumes and high frictional demand, the use of HL1, DFC, or SMA, HMA, Superpave 12.5 FC1 and 12.5 FC2, and aggregates may be necessary to give adequate frictional properties.

The designer should provide a list of approved aggregate sources for SMA, DFC, Superpave 12.5 FC2 coarse and fine aggregates, and HL 1 and Superpave 12.5 FC1 coarse aggregate.

When specifying Superpave mixes, the designer should specify the traffic category using Table 3 as a guideline.

The designer should ensure that the Ontario Provincial Standards General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

### **Related Ontario Provincial Standard Drawings**

None.





Notes:

1. Enter the type of rock or material used in the mix as follows:
  - G - gravel, HL 1 only
  - DS - dolomitic sandstone
  - T - traprock, diabase, andesite
  - M - meta-arkose, gneiss
2. HL 1, SMA, DFC, Superpave 12.5 FC1 and 12.5 FC2 only: When control charts for  $n > 20$  are used for LS-601, the average value shall not exceed the specification maximum of 1.0%, with no single value greater than 1.4%.
3. These physical requirements for HL 4 apply when the HMA forms the surface upon which vehicular traffic will directly travel, otherwise, the physical requirements for HL 4 binder apply.
4. HL 3, HL 4, HL 8, HDBC, and MDBC only: When control charts for  $n > 20$  are used for LS-601, the average value shall not exceed 1.3% with no single value greater than 1.7%. When quarried rock is used, a maximum of 2.0% passing the 75  $\mu\text{m}$  sieve is permitted. When control charts for  $n > 20$  are used for LS-601 for quarried rock, the average value shall not exceed 2.0%, with no single value greater than 2.4%.
5. For traffic categories D and E, Superpave 19.0 shall be 15% maximum.
6. This requirement is applicable to surface course aggregates in the area to the north and west of a boundary defined as follows: the north shore of Lake Superior, the north shore of the St Mary's River, the south shore of St. Joseph Island, the north shore of Lake Huron easterly to the north and east shore of Georgian Bay, excluding Manitoulin Island, along the Severn River to Washago and a line easterly passing through Norland, Burnt River, Burleigh Falls, Madoc, and hence easterly along Highway 7 to Perth and northerly to Calabogie and easterly to Arnprior and the Ottawa River.

When the aggregate for surface course mix is obtained from a gravel or quarry source containing more than 40% carbonate rock type, limestone and dolostone in the retained 4.75 mm portion, blending with non-carbonate aggregate is required to increase the non-carbonate rock type content to a minimum of 60% of the retained 4.75 mm portion. The method of blending shall be such as to produce a uniform product and is subject to approval by the Owner. In cases of dispute, the acid insoluble residue test LS-613 shall be used with a minimum acid insoluble residue of 60%. When the aggregate for surface course mix is obtained from a non-carbonate gravel or quarry source, blending with carbonate rock types shall not be permitted.
7. This only applies to aggregate crushed from gravel sources.
8. This requirement may be waived by the Owner when the aggregate meets the alternative magnesium sulphate soundness requirements, LS-606.

**Appendix 1003-D, Additional information for OPSS 1003, November 2004**

**Note:** This appendix is not a mandatory part of the standard specification. However, it is written in mandatory language to permit invoking it by reference in the Contract Documents.

OPSS 1003 is modified by the addition of the following gradation requirements for fine and coarse aggregates:

**Table D-1  
OPSS 1003 - Gradation for Fine Aggregate, LS-602**

MTO Sieve Designation	Percent Passing by Mass				
	DFC	HL 1 and HL 3	HL 2	HL 4, HL 8, and MDBC	HDBC
9.5 mm	100	100	100	100	100
4.75 mm	85 - 100	90 - 100	85 - 100	85 - 100	95 - 100
2.36 mm	65 - 95	70 - 100	70 - 90	60 - 100	80 - 100
1.18 mm	48 - 80	50 - 90	50 - 75	34 - 90	50 - 90
600 µm	25-60	30 - 70	30 - 55	17 - 70	28 - 70
300 µm	10 - 35	15 - 40	15 - 35	9 - 40	10 - 40
150 µm	5 - 15	5 - 15	5 - 15	3 - 15	0 - 15
75 µm	0 - 6	0 - 5	3 - 8	0 - 7	0 - 5

Note:  
A. The difference between the amount retained between any two consecutive sieves, excluding the 75 µm sieve shall not be less than 5%.

**Table D-2  
OPSS 1003 - Gradation for Coarse Aggregate, LS-602**

MTO Sieve Designation	Percent Passing by Mass		
	HL 1, DFC, and HL 3	HL 4	HL 8, MDBC, and HDBC
26.5 mm	-	-	100
19.0 mm	-	100	90 - 100
16.0 mm	100	96 - 100	65 - 90
13.2 mm	96 - 100	67 - 86	-
9.5 mm	50 - 73	29 - 52	20 - 55
6.7 mm	-	-	-
4.75 mm	0 - 10	0 - 10	0 - 10

